On-Site Ambulance Investigation
SCI Case No.: DS11018
Vehicle: 2007 Ford E-350 Ambulance
Location: California
Incident Date: May 2011

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The crash investigation process is an inexact science which requires that physical evidence such as skid marks, vehicular damage measurements, and occupant contact points be coupled with the investigator's expert knowledge and experience of vehicle dynamics and occupant kinematics in order to determine the pre-crash, crash, and post-crash movements of involved vehicles and occupants.

Because each crash is a unique sequence of events, generalized conclusions cannot be made concerning the crashworthiness performance of the involved vehicle(s) or their safety systems.

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16. Abstract

This on-site investigation focused on the crash dynamics and injuries sustained in a crash involving a 2007 Ford E350 Econoline van that was configured as a Type II ambulance. The crash occurred on a westbound interstate highway in May 2011 at 0605 hours.

The Ford was being driven by a restrained 25-year-old male and an unrestrained 23-year-old male Emergency Medical Technician (EMT) was in the rear of the vehicle. The Ford was traveling westbound in the second lane from the right of a five-lane roadway at a GPS-reported speed of 102 km/h (63 mph). The vehicle veered to the right, crossed over a paved shoulder, and impacted a guardrail. The Ford continued traveling west and entered and impacted a concrete drainage ditch. As the Ford traveled within the ditch, the right rear impacted an elevated portion of the ditch. The Ford continued on and impacted a freeway overhead sign support pole with its front end. The Ford came to rest facing northwest. The Ford was towed from the scene due to damage and placed on a police hold. The driver sustained a lung contusion and a closed head injury. The rear EMT occupant was fatally injured.

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Crash Investigation
Case Number: DS11018

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BACKGROUND

This on-site investigation focused on the crash dynamics and injuries sustained in a crash involving a 2007 Ford E350 Econoline van that was configured as a Type II[1] ambulance **(Figure 1**). The crash occurred on a westbound interstate highway in May 2011 at 0605 hours.

Figure 1. 2007 Ford E350 ambulance

The Ford was being driven by a restrained 25-year-old male and an unrestrained 23-year-old male Emergency Medical Technician (EMT) was in the rear of the vehicle. The Ford was traveling westbound in the second lane from the right of a five-lane roadway at a GPS-reported speed of 102 km/h (63 mph). The vehicle veered to the right, crossed over a paved shoulder, and impacted a guardrail. The Ford continued traveling west and entered and impacted a concrete drainage ditch. As the Ford traveled within the ditch, the right rear impacted an elevated portion of the ditch. The Ford continued on and impacted a freeway overhead sign support pole with its front end. The Ford came to rest facing northwest. The Ford was towed from the scene due to damage and placed on a police hold. The driver sustained a lung contusion, and a closed head injury. The rear EMT occupant was fatally injured.

This incident was identified in an internet news article by National Highway Traffic Safety Administration's (NHTSA's) Office of Emergency Medical Services (OEMS). On May 10, 2011 the news article was forwarded to DSI by the Crash Investigation Division (CID) with instructions to locate the vehicle. DSI contacted the police agency and, after several attempts, was able to locate one of the investigating officers and a preliminary police report was obtained. The vehicle had been placed on an extended evidentiary hold and could not be inspected until their field investigation was completed and the district attorney released the vehicle. On September 27, 2011 the vehicle was released and DSI contacted the vehicle owner. Permission to inspect the vehicle was obtained on September 27, 2011 and the case was assigned the same day. Field work was completed on September 30, 2011.

[1]Type II ambulances are based on modern passenger/cargo vans.

CRASH SUMMARY

Crash Site

This crash occurred alongside a westbound 5-lane, divided interstate roadway (**Figure 2**). The roadway was separated from eastbound traffic by a concrete median wall. The first travel lane from the left was a High Occupancy Vehicle (HOV) lane that was separated on the left by an asphalt shoulder and separated from the adjacent travel lane by painted yellow lines. The four travel lanes were separated from each other by white painted lines. To the right of the northernmost lane, there was a 3.0 m (10.0 ft) concrete shoulder, a wood/metal guardrail, a 1.2 m (4.0 ft) concrete drainage ditch, and a chain link fence. A 60.0 cm (23.6 in) diameter metal overhead sign support pole was located 1.5 m (5.0 ft) north of the north road edge. The roadway surface composition was concrete in good condition and the posted speed limit was 105 km/h (65 mph). At the time of the crash, conditions were dawn, cloudy, and dry. The temperature at the nearest reporting station was 13.0° C (55.4° F), the wind speed was 12.8 km/h (8.0 mph), and the visibility was 16.0 km (10 mi). A crash diagram is included at the end of this report.

Figure 2. Overview of westbound approach

Pre-Crash

The driver and rear occupant were employees of the ambulance company. Their duties involved transporting patients between hospitals. The driver slept for approximately 4.5 hours during the 24 hours preceding the crash. An overview of the driver's activities is shown below.

Hours	**Activity**
0800	Ended night shift.
0900-1400	Attended re-certification class.
1500-1900	Slept
2000	Began shift.
2005 (approx.)	Call for service. Patient transfer.
2212-2354	Patient transfer.
2355-0005	10 minute break.
0057-0224	Patient transfer.
0308-0425	Patient transfer.
0511	Completed assignment.
0512-0550	Lunch break. Driver and Occupant 2 slept in rear of vehicle until being paged.

0550	End of shift.
0550	Departed to return to base. Occupant 2 remained in rear of vehicle.
0605	Time of crash.

After the break, Occupant 2 remained in the rear of the vehicle lying on the gurney. According to the driver, Occupant 2 was asleep, unrestrained, with his head toward the front of the ambulance and the cot at its lowest recline setting.

The Ford was traveling westbound in the second lane from the right of a five-lane roadway at a GPS-reported speed of 102 km/h (63 mph). The driver may have fallen asleep. The vehicle veered to the right and crossed the first travel lane. The driver braked as the Ford entered the right shoulder and departed the roadway (**Figure 3**).

Figure 3. Right roadway departure and impacts with guardrail and concrete drainage ditch (Events 1 and 2)

Crash

There were four events in this crash. After departing the roadway, the Ford impacted a guardrail (Event 1). The frontal air bags in the Ford probably deployed at this time. The Ford penetrated and overrode the guardrail as it continued traveling west and entered and impacted a concrete drainage ditch with its right front tire (Event 2). As the Ford traveled within the ditch it was redirected in a western orientation. The vehicle continued traveling west and right rear impacted an elevated portion of the ditch (Event 3). **Figure 4** shows the impact with the concrete ditch and the path toward the sign support pole. The Ford continued on and impacted a freeway overhead sign support pole with its front end (Event 4). The pole sustained minor cosmetic damage and was later repainted. Based on the final damaged appearance of the vehicle, the barrier algorithm of the WinSMASH program computed a Total Delta-V of 84.0 km/h (52.0 mph). The longitudinal and lateral components were -84.0 km/h (-52.0 mph) and 0 km/h, respectively.

Figure 4. Impact with concrete ditch (Event 3) and path to impact with support pole (Event 4)

Post-Crash

The Ford came to rest facing northwest **(Figure 5**). A portion of the guardrail bent outward into the travel lane. Several witnesses responded to the crash. They first helped the driver exit the vehicle.

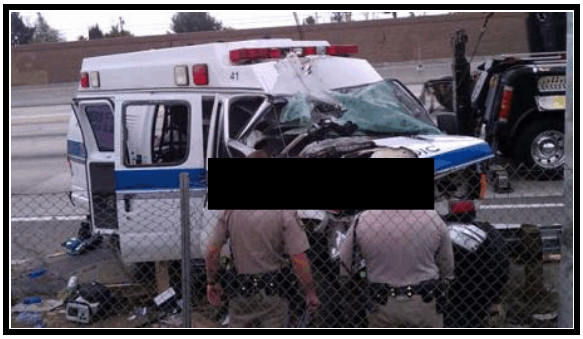

Figure 5. Vehicle final rest, internet photo

The driver sustained a lung contusion and a closed head injury and was transported to a local hospital where he was treated and released at 1030 hours (3.5 hours post-crash). The witnesses asked the driver if he had a partner and if he was in the back of the ambulance. When he answered, "yes",the witnesses went to the right side of the vehicle and opened the side doors. At first they did not see the anyone inside due to the pile up of debris. After removing some of the debris, they located Occupant 2. He was lying down, facing the side door, curled up in a fetal position. One of the witnesses attempted to obtain vital signs but was unable to detect any signs. While the witnesses were in the ambulance, the guardrail was struck by an unknown vehicle. This caused the ambulance to move and the witnesses decided to remove Occupant 2 from the vehicle. Once out of the vehicle, the witnesses began CPR. They continued their efforts until the fire department arrived. Occupant 2 was transported to a local hospital and was declared deceased at approximately 0907 hours (three hours post-crash).

The Ford was towed from the scene due to damage and placed on a police hold.

2007 FORD E350 AMBULANCE

Description

The 2007 Ford E350 Econoline was identified by the Vehicle Identification Number (VIN): 1FDSS34P97Dxxxxxx. The Ford was an extended van that was configured as a Type II ambulance. The incomplete chassis was manufactured in January 2007. The ambulance manufacturer was Leader Industries and the date of manufacture was May 2007. The vehicle mileage is not known. The Ford was equipped with a 6.0-liter, 8-cylinder diesel engine, an automatic transmission, and rear wheel drive. The vehicle was configured with modular body components, dual rear doors, dual right side doors, and a lights and siren warning system. The Ford was equipped with Michelin LTX LT245/75R16 tires. The vehicle manufacturer's recommended cold tire pressure was 414 kPa (60 psi) for the front tires and 552 kPa (80 psi) for the rear tires; the tire manufacturer's maximum pressure was 552 kPa (80 psi). The tires were manufactured during 2010 and the specific tire data at the time of the vehicle inspection[2] was as follows:

Position	Measured Pressure	Measured Tread Depth	Restricted	Damage
LF	Tire Flat	10 mm (13/32 in)	No	Sidewall holed
LR	483 kPa (70 psi)	10 mm (13/32 in)	No	None
RR	393 kPa (57 psi)	10 mm (13/32 in)	No	Sidewall cut
RF	490 kPa (71 psi)	10 mm (13/32 in)	Yes	None

The seating in the Ford was configured with front bucket seats with integral head restraints. The body interior included one rear-facing seat and a set of three left-facing seats arranged as a bench. On the left side of the floor there was a cot clamp and a set of antler brackets.

[2] The tires were inspected four months post-crash.

A Stryker Rugged MX-Pro ambulance cot was located in the vehicle. The cot weighed 37 kg (81 lbs) and had a capacity of 295 kg (650 lbs). The cot was 58 cm (23 in) wide and had a standard length of 203 cm (80 in). At the time of the vehicle inspection the mattress was off and the cot was not attached to the floor clamp.

Exterior Damage

There were four events in this crash. The Ford sustained frontal damage from the impacts with the guardrail (Event 1) and the pole (Event 4). The severe pole impact damage masked the guardrail damage. The direct damage from the pole began 20.0 cm (7.8 in) left of right front bumper corner and extended 64.0 cm (25.2 in) to the left. There was contact damage that extended vertically from the bumper to the fiberglass shell at the windshield header. The bumper was displaced from the vehicle. A stringline was extended from the left frame rail to the right frame rail. Six crush measurements were documented along the stringline as follows: C_1 = 40.0 cm (15.7 in), C_2 = 45.0 cm (17.7 in), C_3 = 54.0 cm (21.2 in), C_4 = 64.0 cm (25.2 in), C_5 = 71.0 cm (27.9 in), C_6 = 83.0 cm (32.7 in). The displaced bumper was located and a crush profile was generated by measuring along the bumper face and comparing the bumper attachment points with the frame rails (**Figure 6**). The resulting crush profile was as follows: C_1 = 42.0 cm (16.5 in), C_2 = 57.0 cm (22.4 in), C_3 = 114.0 cm (44.9 in), C_4 = 114.0 cm (44.8 in), C_5 = 110.0 cm (43.3 in), C_6 = 44.0 cm (17.3 in). The Collision Deformation Classification (CDC) for the frontal impact with the pole was 12FZAW7.

Figure 6. Bumper crush profile

The impacted the right side of the concrete drainage ditch with its right front tire. Scratches were documented on the ditch. The estimated CDC for this impact was 12FRWN3.

The vehicle sustained minor right side damage from impact with the concrete drainage ditch **(Figure 7**). The direct damage began 99.0 cm (38.9 in) rear of the rear axle and extended 54.0 cm (21.2 in) forward. The damage was located 107.0 cm (42.1 in) above the ground and measured 43.0 cm (16.9 in) in height. Six crush measurements were documented along the right side as follows: C_1 = 6.0 cm (2.4 in), C_2 = 3.0 cm (1.2 in), C_3 = 2.0 cm (0.8 in), C_4 = 1.0 cm (0.4 in), C_5 = 1.0 cm (0.4 in), C_6 = 0 cm. The CDC for this impact was 12RBES2.

Figure 7. Right side damage

Interior Damage

The Ford sustained severe interior damage due to intrusion and occupant contacts. The vehicle sustained longitudinal intrusion of the instrument panel, steering wheel, toe pan, and windshield header. There was lateral intrusion to the driver's position from the engine cowling and engine and vertical intrusion from the fiberglass ambulance inner shell.

The top of the steering wheel rim was deformed 7.0 cm (2.8 in) forward (**Figure 8**) and there was shear capsule separation from occupant loading (**Figure 9**).

Figure 8. Steering wheel deformation

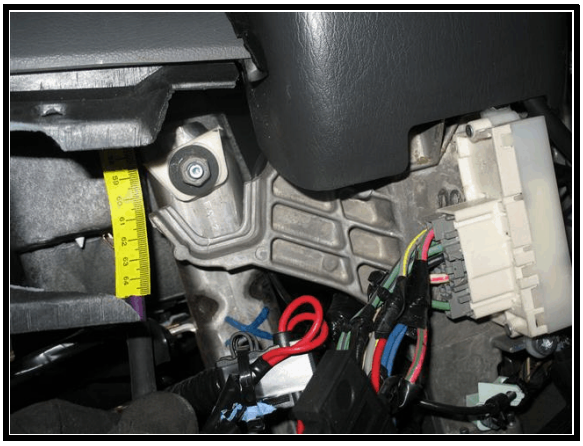

Figure 9. Left shear capsule separation

The right front door was jammed shut. The remaining doors stayed closed and operational. The vehicle sustained integrity loss through the windshield, the frame around the right front door, and the right side window.

A wooden cabinet cluster was located at the front right of the ambulance interior. The cabinets and shelves located approximately 45.0 cm (17.7 in) above the floor were completely displaced and broken by Occupant 2 (**Figure 10**).

Figure 10. Side view of right front cabinetry

Manual Restraint System

The Ford was configured with 3-point manual lap and shoulder belts for the front seat positions. The vehicle was equipped with driver and front right passenger safety belt retractor pretensioners; the driver's belt pretensioner actuated in the crash and the belt was locked in the spooled out position at the time of the vehicle inspection, and there was loading at the D-ring (**Figure 11**). The driver's safety belt anchorage adjustment was in the full-down position. The driver's safety belt was configured with a sliding latch plate.

The vehicle was configured with a lap belt for the rear-facing technician seat and a set of three lap belts for the side-facing right bench seat. None of the rear compartment safety belts were used in this crash.

Supplemental Restraint Systems

The 2007 Ford E350 was equipped with frontal air bags that deployed as a result of the impact with guardrail.

The driver's air bag deployed from the center of the steering wheel hub through H-configuration module flaps (**Figure 12**). The deployed air bag measured 47.0 cm (18.5 in) in width and 50.0 cm (19.7 in) in height in its deflated state. Two circular 3.0 cm (1.2 in) diameter vent ports were located at the 11 and 1 o'clock aspects on the rear panel. There were blood deposits documented on the upper quadrant of the air bag face. There was no damage to the air bag or module covers.

Figure 11. Safety belt webbing load marks

The front right passenger air bag deployed from the top instrument panel. The deployed air bag was entrapped between the seat back and the intruded right instrument panel and could not be pulled free. The air bag was approximately 59.0 cm (23.2 in) wide. Two circular vent ports were located at the 3 and 9 o'clock positions.

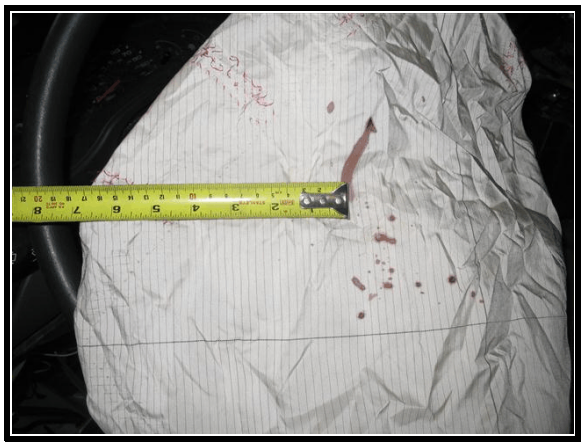

Figure 12. Driver's air bag

2007 FORD E350 OCCUPANTS

Driver Demographics

Age/Sex:	25/Male
Height:	168 cm (66 in)
Weight:	68 kg (150 lbs)
Eyewear:	Unknown
Seat Type:	Bucket
Seat Track Position:	Unknown
Manual Restraint Usage:	Lap and shoulder belt
Usage Source:	Vehicle inspection
Air Bags:	Steering wheel mounted frontal air bag deployed
Alcohol/Drug Data:	None
Egress from Vehicle:	With assistance from witnesses
Transport from Scene:	Transported by ground ambulance
Medical Treatment:	Treated and released at 1030 hours.

Driver Injuries

Inj. No.	Injury	AIS 2005/08	Injury Source	Confidence Level
1	Lung contusion	441402.3,9	Steering wheel	Probable
2	Closed head injury	100099.9,9	Unknown	Unknown
3	Laceration, right lower leg	810600.1,1	Lower instrument panel	Probable
4	Laceration, inner bottom lip	210600.1,8	Driver air bag	Probable
5	Contusion, left hip	810402.1,2	Seat belt webbing	Probable
6	Laceration, right knee	810600.1,1	Lower instrument panel	Probable

Source: Discharge summary and radiology reports

Driver Kinematics

The 25-year-old male driver of the Ford was seated in a unknown posture. He was wearing the 3-point manual lap and shoulder belt. Prior to the impact with the guardrail, the scene evidence indicates that the driver was braking and steering to the right. At impact, the driver was displaced forward. He loaded the pretensioned lap and shoulder belt and the deployed frontal air bag. As the Ford went into the concrete ditch and was redirected, the driver was displaced forward and to the right. As the Ford continued west, there was a swiping type impact to the right side that probably did not displace the driver. At impact with the pole, the driver was displaced forward. He loaded the steering column with his torso and sustained a lung contusion. Both of his knees and his right lower leg engaged the lower instrument panel, causing a knee and lower leg laceration.

Rear Compartment Occupant Demographics

Age/Sex:	23 year/Male
Height:	188 cm (74 in)
Weight:	114 kg (251 lbs)
Eyewear:	Unknown
Seat Type:	N/A - Lying down on ambulance cot
Manual Restraint Usage:	None
Usage Source:	Vehicle inspection
Alcohol/Drug Data:	None
Egress from Vehicle:	Removed from vehicle by witnesses
Transport from Scene:	Transported by ground ambulance
Medical Treatment:	Declared deceased at 0907 hours

Rear Compartment Occupant Injuries

Inj. No.	Injury	AIS 2005/08	Injury Source	Confidence Level
1	Subdural hemorrhage	140438.3,6	Storage cabinet	Certain
2	Pulmonary contusions	441402.3,9	Storage cabinet	Certain
3	Multiple rib fractures	450210.2,9	Storage cabinet	Certain
4 5 6 7	Fractures to the spinal cord C1- through C-4	650216.2,6 650216.2,6 650216.2,6 650216.2,6	Storage cabinet	Probable
8	Skull fractures	150000.2,9	Storage cabinet	Certain
9	Fracture, 7th thoracic vertebra	650416.2,7	Storage cabinet	Probable
10	Mediastinal hemorrhage	442208.2,4	Storage cabinet	Certain
11	Laceration, 0.4 cm (1.0 in), above eyebrows	210600.1,7	Storage cabinet	Certain
12	Laceration, bridge of nose	210600.1,4	Storage cabinet	Certain
13	Contusion, left lower eye	210402.1,2	Storage cabinet	Certain
14	Contusion, bridge of nose	210402.1,4	Storage cabinet	Certain
15	Abrasion, left cheek	210202.1,2	Storage cabinet	Certain
16	Abrasion, above base of neck on left side	310202.1,2	Storage cabinet	Certain
17	Multiple abrasions, left shoulder	710202.1,2	Storage cabinet	Certain
18	Abrasions: 10 x 2.5 cm (4 x 1 in) posterior right shoulder, triceps	710202.1,1	Storage cabinet	Certain
19	Contusion, 20 x 5 cm (8 x 2 in), posterior centerline, 30.4 cm (12 in) below neck	410402.1,6	Storage cabinet	Certain

Inj. No.	Injury	AIS 2005/08	Injury Source	Confidence Level
20	Abrasion, posterior, above buttocks	410402.1,6	Storage cabinet	Certain
21	Abrasion, left upper buttock	810202.1,2	Storage cabinet	Certain

Source: Coroner's examination, review of hospital medical records by coroner personnel, CT scan

Rear Compartment Occupant Kinematics

The 23-year-old male rear area occupant was lying on the Stryker ambulance cot. According to the driver, Occupant 2 was asleep, unrestrained, with his head toward the front of the ambulance and the cot at its lowest recline setting. At impact with the guardrail and the concrete culvert, he was displaced forward and to the right. He probably remained on the cot. At impact with the pole, he was displaced forward and impacted the cabinetry located primarily on the front right of the rear compartment (**Figure 13**). The damage was generally at the level of the ambulance cot. This occupant sustained skull, rib and spinal fractures from contact to the cabinet. He also sustained brain and lung injuries, as well as multiple contusions, abrasions, and lacerations. This occupant was covered in debris post-crash. He was found lying down, facing the side door, curled up in a fetal position. He was transported to a local hospital and was declared deceased at approximately 0907 hours (two hours post-crash).

Figure 13. Right front cabinetry

CRASH DIAGRAM